U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject:	AIRPLANE SIMULATOR QUALIFICATION	**Date:** 1/24/92 **Initiated by:** ASO-205	**AC No:** 120-40B **Change:** 1

1. PURPOSE: This Change clarifies procedures for the requalification of simulators which have been removed from active status for prolonged periods. Paragraph 10, Recurrent Evaluation, subpart f(5), has created some confusion concerning the establishment of new qualification basis for simulators which have been out of service longer than 1 year. It was not originally intended that simulators out of service for 1 year or longer automatically establish a new qualification status. Additionally, this Change corrects a reference number that was incorrect in the original advisory circular. It also inserts an effective date that was inadvertently omitted from the original advisory circular.

The Change number and date of the changed material are carried at the top of the page. Pages having no changes retain the same heading information.

2. PRINCIPAL CHANGES: Paragraph 10, Recurrent Evaluation, subpart f(5), has been edited and a new subpart, f(6), has been added to clarify procedures for the requalification of inactive simulators.

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U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject:	AIRPLANE SIMULATOR QUALIFICATION	Date: 7/29/91	AC No: 120-40B
		Initiated by: ASO-205	Change:

1. PURPOSE. This advisory circular (AC) provides an acceptable means, but not the only means, of compliance with the Federal Aviation Regulations (FAR) regarding the evaluation and qualification of airplane simulators used in training programs or airmen checking under Title 14 Code of Federal Regulations (CFR). Criteria specified in this AC are those used by the Federal Aviation Administration (FAA) to determine whether a simulator is qualified and the qualification level. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the pertinent FAR. Mandatory terms used in this AC such as "shall" or "must" are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described herein is used. Applicable regulations must also be referenced to assure compliance with the provisions therein. This AC does not change regulatory requirements or create additional ones, and does not authorize changes in, or deviations from, regulatory requirements. The provisions of the FAR are controlling. This document does not interpret the regulations. Interpretations are issued only under established agency procedures. This AC applies only to the evaluation of airplane simulators. See, for example, AC 120-45, Advanced Training Devices (Airplane Only) Evaluation and Qualification.

2. CANCELLATION. AC 120-40A, Airplane Simulator and Visual System Evaluation, dated July 31, 1986, is canceled. Operators having simulator improvement or acquisition projects in progress on the effective date of this advisory circular have 90 days from the effective date to notify the National Simulator Program Manager (NSPM) of those projects which the operator desires to complete under the provisions of AC 120-40A.

3. RELATED FAR SECTIONS. FAR Part 1; FAR Sections 61.57, 61.58, and 61.157, FAR Part 61 Appendix A; FAR Section 63.39, FAR Part 63 Appendix C; FAR Sections 121.407, 121.409, 121.439, and 121.441; FAR Part 121 Appendices E, F, and H; FAR Sections 125.285, 125.287, 125.291, and 125.297; and FAR Sections 135.293, 135.297, 135.323, and 135.335.

4. RELATED READING MATERIAL. AC 120-28C, Criteria for Approval of Category III Landing Weather Minima; AC 120-29, Criteria for Approving Category I and Category II Landing Minima for FAR 121 Operators; AC 120-35B, Line Operational Simulations: Line-Oriented Flight Training, Special Purpose Operational Training, Line Operational Evaluation; AC 120-41, Criteria for Operational Approval of Airborne Wind Shear Alerting and Flight Guidance Systems; AC 120-45, Advanced Training Devices (Airplane Only) Evaluation and Qualification; AC 120-46, Use of Advanced Training Devices (Airplane Only); AC 150/5300-13, Airport Design; AC 150/5340-1F, Marking of Paved Areas on Airports; AC 120-150/5340-4C, Installation Details for Runway Centerline Touchdown Zone Lighting Systems; AC 150/5340-19, Taxiway Centerline Lighting System; AC 150/5340-24, Runway and Taxiway Edge Lighting System; and AC 150-5345-28D, Precision Approach Path Indicator (PAPI) Systems.

5. BACKGROUND.

a. The availability of advanced technology has permitted greater use of flight simulators for training and checking of flight crewmembers. The complexity, costs, and operating environment of modern aircraft also has encouraged broader use of advanced simulation. Simulators can provide more indepth training than can be accomplished in airplanes and provide a very high transfer of learning and behavior from the simulator to the airplane. The use of simulators, in lieu of airplanes, results in safer flight training and cost reductions for the operators. It also achieves fuel conservation and reduction in adverse environmental effects.

b. As technology progressed and the capabilities of flight simulation were recognized, FAR revisions were made to permit the increased use of simulators in approved training programs. Simulators have been used in training and some checking programs since the middle 1950's. Various FAR amendments gradually permitted additional simulator credits. The most significant recognition of simulator capability has occurred since the early 1970's. In December 1973, FAR Amendments 61-62 and 121-108 permitted additional use of visual simulators. Amendments to FAR Section 121.439 permitted simulators approved for "the landing maneuver" to be substituted for the airplane in a pilot recency of experience qualification. These changes to the FAR constituted a significant step toward the development of Amendments 61-69 and 121-161 issued June 24, 1980, which contained the FAA Advanced Simulation Plan. To support this plan, the National Simulator Evaluation Program was established by the FAA in October 1980. The program is administered and directed by the NSPM.

c. The need for standard criteria was necessitated by the use of simulators for training and checking. The evolution of the simulator technology and the concomitant increased permitted use has required a similar evolution of the criteria for simulator qualification. A listing of known simulator criteria should, therefore, be informative. The qualification basis for a given simulator may be any of the past criteria, depending on when the simulator was first approved or last upgraded. The following list provides the effective dates of simulator qualification criteria documents:

FAR Part 121, Appendix B	1/9/65 to 2/2/70
AC 121-14	12/19/69 to 2/9/76
AC 121-14A	2/9/76 to 10/16/78
AC 121-14B	10/16/78 to 8/29/80
FAR Part 121, Appendix H	6/30/80 to Present
AC 121-14C	8/29/80 to 1/31/83
AC 120-40	1/31/83 to 7/31/86
* AC 120-40A	7/31/86 to 7/29/91 *

Each of these documents has addressed the greater complexity represented by succeeding generations of simulators. Complexity of the highest level is not, however, required of all simulators. In fact, simulators are divided into levels

(7) SOC with certain requirements. SOC's must provide references to sources of information for showing compliance, rationale to explain how the referenced material is used, mathematical equations and parameter values used, and conclusions reached. Refer to appendix 1, "Simulator Standards," comments column, for SOC requirements.

(8) Recording procedures or required equipment for the validation tests.

(9) The following for each validation test designated in appendix 2 of this AC:

(i) Name of the test.
(ii) Objective of the test.
(iii) Initial conditions.
(iv) Manual test procedures.
(v) Automatic test procedures (if applicable).
(vi) Method for evaluating simulator validation test results.
(vii) Tolerances for relevant parameters.
(viii) Source of Airplane Test Data (document and page number).
(ix) Copy of Airplane Test Data.
(x) Simulator Validation Test Results as obtained by the operator.
(xi) A means, acceptable to the NSPM, of easily comparing the simulator test results to airplane test data.

c. The operator's simulator test results must be recorded on a multichannel recorder, line printer, or other appropriate recording media acceptable to the NSPM. Simulator results should be labeled using terminology common to airplane parameters as opposed to computer software identifications. These results should be easily compared with the supporting data by employing cross-plotting, overlays, transparencies, or other acceptable means. Airplane data documents included in an ATG may be photographically reduced only if such reduction will not alter the graphic scaling or cause difficulties in scale interpretation or resolution. Incremental scales on graphical presentations must provide the resolution necessary for evaluation of the parameters shown in appendix 2. The test guide will provide the documented proof of compliance with the simulator validation tests in appendix 2. In the case of a simulator upgrade, an operator should run all validation tests for the requested qualification level. Validation test results offered in a test guide for a previous initial or upgrade evaluation should not be used to validate simulator performance in a test guide offered for a current upgrade. For tests involving time histories, flight test data sheets, or transparencies thereof, and simulator test results should be clearly marked with appropriate reference points to ensure an accurate comparison between simulator and airplane with respect to time. Operators using line printers to record time histories should clearly mark that information taken from the line printer data output for cross-plotting on the airplane data. The cross-plotting of the operator's simulator data to airplane

data is essential to verify simulator performance in each test. During an evaluation, the FAA will devote its time to detailed checking of selected tests from the ATG. The FAA evaluation serves to validate the operator's simulator test results.

d. The completed ATG and the operator's compliance letter and request for the evaluation will be submitted through the operator's POI. The POI will then submit the total package with a letter or memorandum of endorsement to the NSPM. The ATG will be reviewed and determined to be acceptable prior to scheduling an evaluation of the simulator.

e. A copy of an ATG for each type simulator by each simulator manufacturer will be required for the NSPM's file. The NSPM may elect not to retain copies of the ATG for subsequent simulators of the same type by a particular manufacturer, but will determine the need for copies on a case-by-case basis. Data updates to an original ATG should be provided to the NSPM in order to keep FAA file copies current.

f. The operator may elect to accomplish the ATG validation tests while the simulator is at the manufacturer's facility. Tests at the manufacturer's facility should be accomplished at the latest practical time prior to disassembly and shipment. The operator must then validate simulator performance at the final location by repeating at least one-third of the validation tests in the ATG and submitting those tests to the NSPM. After review of these tests, the FAA will schedule an initial evaluation. The ATG must be clearly annotated to indicate when and where each test was accomplished.

g. In the event an operator moves a simulator to a new location and its level of qualification is not changed, the following procedures shall apply:

(1) Advise the POI and NSPM of the move.

(2) Prior to returning the simulator to service at the new location, the operator should perform a typical recurrent validation and functions test. The results of such tests will be retained by the operator and be available for inspection by the FAA at the next evaluation or as requested.

(3) The NSPM may schedule an evaluation prior to return to service.

h. When there is a change of operator, the new operator must accomplish all required administrative procedures including the submission of the currently approved Master Approval Test Guide (MATG) through the POI to the NSPM. The ATG must be identified with the new operator by displaying the operator's name or * logo. The POI will then submit the package as described in paragraph 9d above. * The simulator may, at the discretion of the NSPM, be subject to an evaluation in accordance with the original qualification criteria. However, a simulator having Phase I status resulting from a landing maneuver approval under AC 121-14B must meet the Phase I requirements in FAR Part 121, Appendix H, in the event of the sale or transfer of the simulator from one operator to another.

i. The scheduling priority for initial and upgrade evaluations will be based on the sequence in which acceptable ATG's and evaluation requests are received by the NSPM.

j. The ATG will be approved after the completion of the initial or upgrade evaluation and all discrepancies in the ATG have been corrected. This document, after inclusion of the FAA witnessed test results, becomes the MATG. The MATG will then remain in the custody of the operator for use in future recurrent evaluations.

10. RECURRENT EVALUATIONS.

a. For a simulator to retain its qualification, it will be evaluated on a recurrent basis using the approved MATG. Unless otherwise determined by the NSPM, recurring evaluations will be accomplished every 4 months by a Simulator Evaluation Specialist. Each recurrent evaluation, normally scheduled for 8 hours of simulator time, will consist of functions tests and approximately one-third of the validation tests in the MATG. The MATG is to be completed annually.

b. Dates of recurrent evaluations will normally not be scheduled beyond 30 days of the date due. Exceptions to this policy will be considered by the NSPM on a case-by-case basis to address extenuating circumstances.

c. In the interest of conserving simulator time, the following Optional Test Program (OTP) is an alternative to the 8-hour recurrent evaluation procedure:

(1) Operators of simulators having the appropriate automatic recording and plotting capabilities may apply for evaluation under the OTP.

(2) Operators must notify the NSPM in writing of their intent to enter the OTP. If the FAA determines that the evaluation can be accommodated with 4 hours or less of simulator time, recurrent evaluations for that simulator will be planned for 4 hours. If the 4-hour period is or will be exceeded and the operator cannot extend the period, then the evaluation will be terminated and must be completed within 30 days to maintain qualification status. The FAA will then reassess the appropriateness of the OTP.

(3) Under the OTP, at least one-third of all the validation tests will be performed and certified by operator personnel between FAA recurrent evaluations. Complete coverage will be required through any three consecutive recurrent evaluations. These tests and results will be reviewed by the FAA Simulator Evaluation Specialist at the outset of each evaluation. The one-third of validation tests executed for each recurrent evaluation should be accomplished within the 30 days prior to the scheduled evaluation or accomplished on an evenly distributed basis during the 4-month period preceding the scheduled evaluation. Twenty percent of those tests conducted by the operator for each recurrent evaluation will then be selected and repeated by the Simulator Evaluation Specialist along with 10 percent of those tests not performed by the operator.

d. With appropriate arrangement and understanding between the operator and FAA, an extended interval recurrent evaluation schedule based on semiannual FAA inspections can be arranged. The extended interval evaluation schedule relies on quarterly checks by the operator.

e. Prior to arrival for an on-site evaluation, the FAA inspector will notify the operator if any tests are planned to be run that may require special equipment or technicians. These tests would include latencies, control dynamics, sounds and vibrations, or motion system tests.

f. In instances where an operator plans to remove a simulator from active status for prolonged periods, the following procedures shall apply to requalify the simulator pursuant to this AC:

(1) The NSPM and POI shall be advised in writing. The notice shall contain an estimate of the period that the simulator will be inactive.

(2) Recurrent evaluations will not be scheduled during the inactive period. The NSPM will remove the simulator from qualified status on a mutually established date not later than the date on which the first missed recurrent evaluation would have been scheduled.

(3) Before a simulator can be restored to FAA qualified status, it will require an evaluation by the NSPM. The evaluation content and time required for accomplishment will be based on the number of recurrent evaluations missed during the inactive period. For example, if the simulator were out of service for 1 year, it would be necessary to complete the entire test guide since under the recurrent evaluation program, the MATG is to be completed annually.

(4) The operator will notify the NSPM of any changes to the original scheduled time out of service.

* (5) The simulator will normally be requalified using the FAA-approved MATG and criteria that was in effect prior to its removal from qualification; however, inactive periods exceeding 1 year will require a review of the qualification basis.

(6) If these procedures are not possible, the establishment of a new qualification basis will be necessary. *

11. SPECIAL EVALUATIONS.

a. Between recurring evaluations, if deficiencies are discovered or it becomes apparent that the simulator is not being maintained to initial qualification standards, a special evaluation of the simulator may be conducted by the NSPM to verify its status.

b. The simulator will lose its qualification when the NSPM can no longer ascertain maintenance of the original simulator validation criteria based on a recurrent or special evaluation. Additionally, the POI shall advise the operator and the NSPM if a deficiency is jeopardizing training requirements, and arrangements shall be made to resolve the deficiency in the most effective manner, including the withdrawal of approval by the POI.

TABLE OF VALIDATION TESTS (Cont'd)

I = Initial Evaluation
R = Recurrent Evaluation

Test	Tolerance	Flight Condition	Qualification Requirement A	B	C	D	Comments
2. HANDLING QUALITIES (DYNAMIC CONTROL CHECKS** Con't)							
(2) Roll Control	Same as (1) above.	Takeoff, Cruise, Landing			IR	IR	Data should be normal control displacement. Approximately 25% to 50% of full throw.
(3) Yaw Control	Same as (1) above.	Takeoff, Cruise, Landing			IR	IR	Data should be normal control displacement. Approximately 25% to 50% of full throw.
c. LONGITUDINAL							
(1) Power Change Dynamics	±3 Kts Airspeed ±100 Feet (30 Meters) Altitude ±20% or ±1.5° Pitch	Approach to Go-Around	IR	IR	IR	IR	Wing flaps should remain in the approach position. Time history of uncontrolled free response for time increment from 5 seconds before the initiation of the configuration change to 15 seconds after completion of the configuration change.
(2) Flap/Slat Change Dynamics	±3 Kts Airspeed ±100 Feet (30 Meters) Altitude ±20% or ±1.5° Pitch	Retraction, After Takeoff. Extension, Approach to Landing	IR IR	IR IR	IR IR	IR IR	Time history of uncontrolled free response for time increment from 5 seconds before the initiation of the configuration change to 15 seconds after completion of the configuration change.
(3) Spoiler/Speedbrake Change Dynamics	±3 Kts Airspeed ±100 Feet (30 Meters) Altitude ±20% or ±1.5° Pitch	Cruise and Approach	IR	IR	IR	IR	Time history of uncontrolled free response for time increment from 5 seconds before the initiation of the configuration change to 15 seconds after the completion of the configuration change.

TABLE OF VALIDATION TESTS (Cont'd)

I = Initial Evaluation
R = Recurrent Evaluation

Test	Tolerance	Flight Condition	Qualification Requirement A	B	C	D	Comments
2. HANDLING QUALITIES (LONGITUDINAL Con't)							
(4) Gear Change Dynamics	±3 Kts Airspeed ±100 Feet (30 Meters) Altitude ±20% or ±1.5° Pitch	Takeoff to Second Segment Climb, Approach to Landing	IR	IR	IR	IR	Time history of uncontrolled free response for a time increment of 5 seconds before the initiation of the configuration change to 15 seconds after the completion of the configuration change.
(5) Gear and Flap/Slat Operating Times	±1 second or 10% of Time	Takeoff, Approach	IR	IR	IR	IR	Normal and alternate flaps, extension and retraction. Normal gear, extension and retraction. Alternate gear, extension only.
(6) Longitudinal Trim	±1° Pitch Control (Stab and Elev) ±1° Pitch Angle ±5% Net Thrust or Equivalent	Cruise, Approach, Landing	IR	IR	IR	IR	May be Snapshot Tests.
(7) Longitudinal Maneuvering Stability (Stick Force/g)	±5 lbs (±2.224 daN) or ±10% Column Force or Equivalent Surface	Cruise, Approach, Landing	IR	IR	IR	IR	May be series of Snapshot Tests. Force or surface deflection must be in correct direction. Approximately 20°, 30°, and 45° bank angle should be presented
* (8) Longitudinal Static Stability	±5 lbs (±2.224 daN) or ±10% Column Force or Equivalent Surface	Approach	IR	IR	IR	IR	Data for at least 2 speeds above and 2 speeds below trim speed. May be a series of Snapshot Tests. *

TABLE OF VALIDATION TESTS (Cont'd)

I = Initial Evaluation
R = Recurrent Evaluation

Test	Tolerance	Flight Condition	Qualification Requirement A	B	C	D	Comments
2. HANDLING QUALITIES (LONGITUDINAL Con't)							
(9) Stick Shaker, Airframe Buffet, Stall Speeds	±3 Kts Airspeed ±2° Bank for speeds higher than stick shaker or initial buffet	Second Segment Climb and Approach or Landing	IR	IR	IR	IR	Stall Warning Signal should be recorded and must occur in the proper relation to stall.
(10) Phugoid Dynamics	±10% of Period ±10% of Time to 1/2 or Double Amplitude or ±.02 of Damping Ratio	Cruise	IR	IR	IR	IR	Test should include 3 full cycles (6 overshoots after input completed) or that sufficient to determine time to 1/2 amplitude whichever is less.
(11) Short Period Dynamics	±1.5° Pitch or ±2°/sec. Pitch Rate ±.10g Normal Acceleration	Cruise		IR	IR	IR	
d. LATERAL DIRECTIONAL							
(1) Minimum Control Speed, Air (V_{mca}), per Applicable Airworthiness Standard or Low Speed Engine Inoperative Handling Characteristics in Air	±3 Kts Airspeed	Takeoff or Landing (Whichever is most critical in airplane)	IR	IR	IR	IR	V_{mca} may be defined by a performance or control limit which prevents demonstration of V_{mca} in the conventional manner.
* (2) Roll Response (Rate)	±10% or ±2°/sec. Roll Rate	Cruise and Approach or Landing	IR	IR	IR	IR	Test with normal wheel deflection (about 30%). *

TABLE OF VALIDATION TESTS (Cont'd)

I = Initial Evaluation
R = Recurrent Evaluation

Test	Tolerance	Flight Condition	Qualification Requirement A	B	C	D	Comments
2. HANDLING QUALITIES (LATERAL DIRECTIONAL Con't)							
(3) Roll Response to Roll Controller Step Input	±10% or ±2°/sec. Roll Rate	Approach or Landing	IR	IR	IR	IR	Roll rate response.
(4) Spiral Stability	Correct Trend, ±2° Bank or ±10% in 20 Seconds	Cruise	IR	IR	IR	IR	Airplane data averaged from multiple tests may be used. Test for both directions.
(5) Engine Inoperative Trim	±1° Rudder Angle or ±1 Tab Angle or Equivalent Pedal ±2° Sideslip Angle	Second Segment and Approach or Landing	IR	IR	IR	IR	May be Snapshot Tests.
(6) Rudder Response	±2°/sec. or ±10% Yaw Rate	Approach or Landing	IR	IR	IR	IR	Test with stability augmentation ON and OFF. Rudder step input of approximately 25% rudder pedal throw.
(7) Dutch Roll, Yaw Damper OFF	±0.5 sec. or ±10% of Period. ±10% of Time to 1/2 or Double Amplitude or ±.02 of Damping Ratio. ±20% or ±1 sec. of Time Difference Between Peaks of Bank and Sideslip.	Cruise and Approach or Landing		IR	IR	IR	Test for at least 6 cycles with stability augmentation OFF.
(8) Steady State Sideslip	For a given rudder position ±2° Bank, ±1° Sideslip, ±10% or ±2° Aileron, ±10% or ±5° Spoiler or Equivalent Wheel Position	Approach or Landing	IR	IR	IR	IR	May be a series of Snapshot Tests.

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS (Cont'd)	SIMULATOR LEVEL A	B	C	D
(ii) Maximum rate.				
(iii) Manual flight control reversion.				
(iv) Flight control system failure modes.				
(v) Other.				
e. APPROACHES				
(1) Nonprecision.	X	X	X	X
(i) Approach procedure(s), one or more of the following.				
-- NDB -- VOR, RNAV, TACAN -- DME ARC -- LOC/BC -- LDA, LOC, SDF -- ASR				
(ii) Missed approach.				
(iii) All engines operating.				
(iv) One or more engines inoperative.				
(2) Precision.	X	X	X	X
(i) PAR.				
(ii) ILS.				
(A) Normal.				
(B) Engine(s) inoperative.				
(C) Category I published approach.				
1 Manually controlled with and without flight director to 100 ft. (30 m.) below CAT I minima.				

TABLE OF FUNCTIONS AND SUBJECTIVE TESTS (Cont'd)	SIMULATOR LEVEL A	B	C	D
2 With crosswind (maximum demonstrated).				
3 With windshear.				
(D) Category II published approach.				
1 Autocoupled, auto-throttle, autoland.				
2 All engines operating missed approach.				
(E) Category III published approach.				
1 With generator failure.				
2 With 10 knot tailwind.				
3 With 10 knot crosswind.				
4 One engine inoperative.				
(iii) Missed approach.				
(A) All engines operating.				
(B) One or more engines inoperative.				
(3) Visual.	X	X	X	X
(i) Abnormal wing flaps/slats.				
(ii) Without glide slope guidance.				
f. VISUAL SEGMENT AND LANDING				
(1) Normal.				
(i) Crosswind (maximum demonstrated).		X	X	X
(ii) From VFR traffic pattern.	---(Reserved)---			